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CERTAIN ALLUREMENTS IN PHYSICS[1]

THERE is no doubt as to the alluring nature of physics. We are led on as reasoning, imaginative dreamers who never attain full intellectual satisfaction but who are always sufficiently rewarded to be happy to participate either as workers or as spectators. The fascinating quality of physics is not our concern here, but in the atmosphere of the recognition of this drawing and compelling power, certain of our present problems will be briefly discussed.

It is doubtful if ever there has been a more inviting appeal to imaginative reason than can be found at present in atomic structure and radiation theories. The search in this field is, in fact, so exciting that we can easily forget the mysteries in our own hypotheses. The progress of the last decade has been rapid. Only thirteen years ago Professor Rutherford in his Winnipeg address set forth the claim that sufficient evidence had at that time been adduced to place the theory of the existence of atoms in the classification of accepted fact. To-day, with perhaps equal conservatism, several details as to the structure of the atom can also be regarded as accepted. The existence of the nucleus, with a diameter of about 10^{-12} cm. or less no one doubts, though our direct evidence is based upon but one type of experiment, namely, the impact of an α particle. The size of the charge of the nucleus, its sign and the fact that α particles and H particles exist in at least some of the nuclei are certainly just as true. But we would be willing to sacrifice a great deal to know more of the content of and arrangement in nuclei. We may be nearer the acceptance of the existence of α particles, protons and electrons as the units of structure

[1] Address of the vice president and chairman of Section B, physics, American Association for the Advancement of Science, Boston, December, 1922.

in all nuclei than some of us realize. Reasonable deductions from isotopic measurements may convince us as to this composition, but at the moment the experiments of Rutherford and Chadwick upon H particles give us the hope of a direct and hence a more valuable means of attack. The extension of the measurement of the masses of isotopes with the remarkable present accuracy developed by Aston and Dempster will undoubtedly lead to the recognition of classifications that will at least indicate, if not prove, nuclear composition, but the interpretation of the H-particle experiments demands a very much higher accuracy. Rutherford and Chadwick have produced H particles from the nuclei of six of nineteen light elements and in five of the six with an increase in total kinetic energy of from 6 to 42 per cent. of the kinetic energy of the colliding α particle. A consideration of the relativity change in mass of the H particle is important, although perhaps not yet profitable. For the kinetic energy of a 7 cm. α particle is $.009c^2$ per gram-atom, c being the velocity of light, hence the change in mass produced by this energy is .009 grams per gram-atom, or in atomic weight units, .009 for each α particle. If at impact 42 per cent. of this energy is acquired by the nucleus and α particle as shown by experiment, there must be a total increase in mass of .42 x .009 or .004 or 0.4 per cent. of the mass of an H particle, or .01 and .03 per cent., respectively, of the masses of aluminum and boron, two of the elements concerned. At least this accuracy in atomic weight measurements must be obtained before a relativity consideration can even begin. The development of highly improved methods is of great importance.

In regard to the arrangement and activities of the extra-nuclear electrons, the status of atomic structure theory is rapidly improving. Three years ago at this session we had a discussion in which a suggested reconciliation of the so-called static and orbital theories was presented. At the present time one can say with a fair degree of confidence that reconciliation is neither probable nor desirable. The static theory appears superior as a picture to be used in the discussion of periodic physical and chemical properties of the elements, the magnetic properties and compound formations. The orbital theory appears to be a more powerful method of attack, partly because it is not hindered by a consideration of the mechanism of radiation and partly because it relies upon principles and mathematical methods instead of upon visualization. The attempt to mix the two would probably seriously decrease the future real benefits of both. The static atom is valuable not merely because the spacial relations can be visualized but also because, to the extent that it affords such an excellent partial explanation of phenomena and is successful in the predictions of properties of new compounds, it must have a measure of truth. But in some respects it is misleading. Conventionality must not be accepted as a reality. The use of the term "cell" leads to a perhaps unconscious satisfaction that does not bear analysis. Moreover, the position of an electron in a cell on the outermost shell seems to make molecular formation much easier than if the electron has any sort of orbital motion. But yet the converse may be nearer the truth. This is not an effort to criticize the static atom theory. It is merely a reminder of the danger of overenthusiasm concerning any explanation that depends upon visualization.

The present orbital theory of atomic structure, as enunciated by Bohr, is strikingly different both as to content and as to value. It is less of a picture and more of a theory. Stability is not neglected but emphasized. So detailed has become the development of the theory that perhaps a brief non-technical description is appropriate to this address. Until recently our orbital conception based upon the work of a number of contributors could be sketched in the following manner. The fundamental assumption was a generalization of Planck's quantum, which not only gave the frequency relation, but stipulated stationary states of an atom system. By orbits, circular or elliptical, with a central nucleus and a single electron radiating as it passed from one stationary state or energy level to another, the Balmer, Paschen and Lyman series of atomic hydrogen and the series of ionized helium were computed with high accuracy. By assuming elliptical orbits and a relativity change in mass of the electron, the fine structure of hydrogen approximately and of ionized helium more exactly, were obtained. Extending the theory and assuming

internal X-ray energy levels, X-ray doublets were computed and found to agree with experiment. By assuming the presence of an unsymmetrical field external to the nucleus and inner electrons, the well known series formulæ of the alkali metals could be quickly derived. By the application of an electric field, not only the general phenomenon but also the details of the Stark effect were obtained. The Zeeman effect was explained as well as was formerly done by the classical theory. By the application of the "correspondence principle" the intensity and state of polarization of lines for large orbits and more approximately for small orbits were obtained. But in this remarkable theoretical work, producing quantitative agreements that were exceedingly impressive, no account was taken of the spacial distribution of orbits and no explanation was given of the variation of physical and chemical properties as shown by the periodic table. We had, then, two pictures of atomic structure, one with electrons in cells and shells, and one with electrons in coplanar orbits. But because a spacial distribution of electron orbits was demanded on several grounds, some progress was made in considering such a distribution by the polyhedral symmetry of electrons which in the coplanar model had the same orbit. Bohr's recent description in the Zeitschrift für Physik of 1922 seems to abandon a rigorous theoretical approach but, at the same time, to profit by the theoretical investigations of the foregoing idealized conditions. He adheres to the quantum theory and applies the correspondence principle as a substitute for our lack of knowledge of the inner connection which determines the possibility of radiation or a quantum change. He concludes that there is no modification in the former hydrogen atom model. The helium atom in the normal state has two approximately circular electron orbits, having an angle between their axes of 120°, with the planes turning slowly about the fixed axis. Preliminary computations promise the experimental value of the ionizing potential. These helium orbits remain a fixed substructure in all elements of higher atomic numbers. Bohr ascertains the structure of succeeding elements in the periodic table by obtaining an answer to the question, "How can the atom be built through successive seizure and binding of the single electrons in the field of force surrounding the nucleus?" He is led by this approach to a conclusion as to the nature of the orbits of the elements. Briefly, the orbits are approximately circular, elliptical and highly elliptical, resulting in an interpenetration of orbits. Electrons having relatively large energies will, on account of the greater ellipticity of their orbits pass closer to the nucleus than do other electrons possessing smaller energies and moving in orbits of less eccentricity. The visits to the interior by a group of electrons in non-coplanar elliptical orbits of a certain energy, do not occur simultaneously, for the electrons approach the nucleus alternately with equal time intervals. Because of the interpenetration of orbits there is an intimate coupling of the electron orbits of the different groups indicated by quantum numbers, and also an independence of the nature of the binding of the electrons of one and the same group. Bohr discusses the entire periodic table, showing how this structure may explain the chemical and physical periodic phenomena. He has abandoned rigorous treatment, merely because it is no longer possible. Another new result of Dr. Bohr's investigation is that at four different regions in the periodic table, the added electrons find more stable adjustments by becoming members of groups formed earlier in the building up process. The ferromagnetic metals are near the end of such an inner change or what might be termed the healing process of an internal wound of the atom.

In the above it is observed that our former relatively simple picture of an orbital atom has gone and we have, in an atom of high atomic weight, a maze of interpenetrating orbits too complicated to visualize. But we have a description of the atom in terms of quantum numbers and nuclear charges. While this remarkable conception looks very promising indeed, we must patiently await a very slowly accumulating rigorous treatment. The forthcoming publications of Dr. Bohr will be received with great interest. He is just publishing an article on X-rays in collaboration with Dr. Coster in which there is derived a very strong support for the main features of the new theory. He has been working out and

will soon publish details in regard to the series spectra and will show that the new views throw much additional light in respect to the main feature and also the quantitative details.

The above description will indicate that an attempted reconciliation between the static and orbital theories would probably prove either unsuccessful or unprofitable. We ought to be willing to use either theory freely wherever of service. But it is almost inevitable that in the future, though we may adhere to pictures for elementary students, in the work of investigation we will get further and further from models and become more and more satisfied with principles which, although not containing ultimate explanations, nevertheless are apparently the nearest approach to the truth. Obviously the function of pictures is seriously limited, for our natural ability to gain by visualization does not increase materially from generation to generation, whereas our power of attack through mathematical investigations based upon principles does accumulate with the elapsing years. It is not surprising, therefore, that it is easy to have more faith in the greater fruitfulness of the orbital theory as compared with the static theory.

It is folly to prophesy seriously as to the direction of future progress in the theory of atomic structure. But there are certain evidences that are worthy of consideration. The quantum theory seemed a few years ago to be a curious as well as a remarkable element in Planck's theory of radiation, the oddity of the quantum reflecting merely the difficulties of the problem. To-day, we regard a quantum theory more seriously. Although not as consistent as the classical theory, its use in radiation is or should be just as orthodox. While formerly we were inclined to call attention to the formal character of the theory and the failure to explain any mechanism underlying it, to-day we realize that neither the classical nor the quantum theory gives us the mechanism. This mechanism, though fundamental, is a detail and the evidences is that we can make progress more rapidly by following a successful formal principle than by speculating about the nature of the mechanism itself. Our willingness to adopt as a working theory such a formal principle is not a fault but a virtue. Such a principle attacks, as it were, from without and its successes and failures are determined in that region. Hence we can not hope to judge or improve the method by speculations from within. Progress in atomic structure can certainly be anticipated by following either the quantum theory or perhaps a substitute not yet suggested. The accumulation of data along our present restricted lines of experimentation must of course be of permanent value. But until another formal principle is found that is more successful than the quantum theory or until a hitherto unsuspected region of observation is opened up, we can scarcely expect any material modification in our present views of atomic structure in so far as they are applicable to experimental test. But we have not arrived. The attack upon the problem has but begun. The allurement remains.

Having commented upon the most attractive problem in physics, I turn now by way of contrast to a field regarded by many as possessing but little interest. During the war many physicists remarked that acoustics was at last coming "into its own." Only in a limited sense was this true. Acoustics does not inquire as to the nature of its assumed continuum and hence is not a fundamental subject. It can never have the attractiveness of a fundamental field in which a small amount of progress may eventually lead to an extensive accumulation of valuable results. The chance of enlivenment in acoustics through new discovery is slight. But while the allurements are less the achievements for an individual may be more satisfactory because of their permanent value. This permanency rests upon two facts. In the first place the truth in the assumptions and approximations are clearly understood and any theoretical advance will not need to be thrown aside because of the incorrectness of the bases adopted. Moreover, the importance of acoustics will not wane. In this respect optics and acoustics are similar, for their interest to the race will last as long as will human vision and audition. Progress in acoustics undoubtedly is limited, but its importance will persist. I speak not as an advocate for greater attention to acoustics, neither would I urge in business one particular line over another. Men will go into big business enterprises, some to win and

some to lose. Other men will be more conservative, taking less of a gambler's chance and consequently neither winning nor losing so great a stake. These differences in adjustment to allurements exist in the field of scientific research as well, and one must select that kind of investigation in which he can be most effective and happy. It is unfortunate, however, that physicists generally do not appreciate that acoustics is a difficult field, begging for the attention of masters of mathematical methods. The late Lord Rayleigh had a great mind, as is attested by his numerous contributions in almost all branches of physics. It has often been wondered why he remained strangely inactive toward such an attractive subject as the electron theory. The speaker, in the absence of information, is of the opinion that Lord Rayleigh's interest was controlled in part by the promised permanency of results. In acoustics he must have been attracted by the substantial correctness of the assumptions, for this insured a corresponding quality in the results obtainable by mathematical processes. It is much to be hoped that acoustics will receive an increasing share of the interest of our mathematicians.

Mathematical difficulties arise in even the most simple acoustical devices. For example, a solution has not been found for the "end correction" of a conical horn. Until recently there has been no theory which included a discussion of the natural vibrations in a conical horn which are not radial, but Dr. V. A. Hoersch has now found how to compute the frequencies of these other resonance frequencies, his solution providing for a horn of any angle, but with an infinite plane flange. An experimental test of this unpublished theoretical investigation has not been made. This same investigator has also shown the reason for the existence of an "optimum" horn angle. When a conical horn is used as a receiver there is an angle for which the amplification will be a maximum, assuming fundamental resonance. This angle is less when the vibration is an overtone than when it is the fundamental of the horn. But measurements demonstrating this effect require the escape of a small amount of energy at the vertex. It has now been proved by a fairly simple theoretical investigation that the cause of an optimum angle is this escape of energy. Were this loss zero, the amplification would continue to increase with decreasing angle until viscosity became a factor of importance. It is clear, then, that the adjustment of a conical horn as an amplifying receiver requires not only a knowledge of the frequencies involved but also of the nature of the apparatus at the vertex even though it may absorb but a small amount of energy. The suggestion should be made, in passing, that the incorrect conception of a conical horn as a collector of the incoming energy should soon be supplanted by a correct recognition of the horn as a resonator.

Acoustic problems are not without attractiveness *per se*. The acoustic wave filters just described in the December *Physical Review* are uncommonly interesting and partly because of the element of surprise. We are familiar with the nature and behavior of the medium and by daily experiences with sound transmission. Yet we are hardly prepared by experience to witness an unobstructed cylindrical tube an inch in diameter and a few inches long that refuses audible transmission to a large group of frequencies. Up to the present time, successful low-frequency-pass, high-frequency-pass and single-band and double-band filters have been constructed. Additional contributions to the theory by other workers, but not published, will probably add filters of a different type. Just what the future usefulness of the acoustic wave filters will be can not be estimated. But the permanency of our method of hearing with air as a medium necessitates the continued importance of methods of filtering which use this same medium. Moreover, as presented, the fundamentals of the theory apply to any medium whatsoever. This may prove of significance in several directions.

But it is not my purpose to discuss present problems of acoustics in any detail. Reference has been made merely to several items of progress in which the speaker's interest has been keen and in which the allurements have certainly been strong. It is appropriate, especially in this laboratory where we are in session to-day, that reference be made to one who here did much for the field of acoustics, Professor Wallace Clement Sabine. The desire is

not to laud his contributions but to speak in simple terms of him as a person. There is very clear in memory his act of kindness to the speaker who was a young experimenter in another laboratory. It betrayed a genuine human interest that, wherever found, compels admiration. His mind was keen and full of suggestions to the students in this Jefferson Physical Laboratory. Although kind and generous, he was intensively a just man. Never aggressive in a bold sense, others sought him out. He was essentially modest, but he had confidence in his mental powers. He was fine in spirit, outwardly highly acceptable and, withal, a splendid type of gentleman. One can not forget him as a person.

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THE ORIGIN AND STRUCTURE OF PLANT GALLS[1]

THE study of the histology of pathological tissues of plants has been very much neglected, especially in America. It is true that more or less extensive studies have been recorded and discussed in the papers on the various diseases of plants but nothing has been done towards bringing this data together into a comprehensive whole. In recent years this phase of botany has begun to attract attention, especially in the case of abnormal growths, which have been referred to under many names, such as cecidia, galls, cancers, hypertrophies and various terms which are more or less indefinite. It is the purpose of this paper to give a brief historical review of the phase of plant pathoanatomy which is involved in these abnormal structures. The fact that the author has made rather extensive studies of those plant galls which are the result of insect stimuli may be a sufficient excuse for attempting to discuss this very broad subject involving similar abnormal plant structures which are attributed to other organisms. Abnormal growths on plants are caused by insects, nematodes, fungi, slime molds, bacteria and chemical and mechanical irritations. Similar growths are also produced on animals; but, in general, it may be said that the causes are not nearly so well understood as in the case of plants. On the other hand the histology of abnormal animal growths has been the subject of much more extensive studies than that of those found on plants.

The plant galls which are caused by insects were among the first to attract attention and the early Greek literature contains many references to them. However, very little real progress was made until Malpighi published his "De Gallis" in 1686. This work was primarily descriptive but the author also advanced the theory that the excitation was due to a poison secreted by the mother insect. Although this idea was disproved long ago, there are some text-books which still retain this so-called "chemical theory" of more than two hundred years ago. The next great advance was about fifty years ago and was marked by Adler's "Ueber den Generations-wechsel der Eichen Gallwespen," a work dealing entirely with oak galls caused by insects. The works of Adler, Beyerinck and their contemporaries gave us very definite information concerning the life history of some of the causal insects and the structures of certain insect galls, and disproved the theory that the excitation was due to a fluid secreted by the mother insect.

The European literature is much more extensive than the American. In this country the major part of the work has been by entomologists but within recent years has attracted the attention of several botanists and papers have been published by Cosens, Rosen and Wells. Felt's "Key to Insect Galls" is the most complete and usable work in our American literature for the determination of these plant growths. He lists and describes more than 1,400 species, a number which is no doubt insignificant when compared with the number of undescribed species. In most cases each species of insect cecidium is confined to a single specific host plant and those that occur on more than one host are restricted to closely related species.

A few species of nematodes are well known as the causes of abnormal plant growths. They are widely distributed throughout the world,

[1] Address of the vice-president and chairman of Section G, Botany, American Association for the Advancement of Science, Boston, December, 1922.

especially in the tropical and subtropical climates and the literature is voluminous. It appears that the Reverend M. J. Berkeley, the mycologist, was the first to describe and figure the nematode root galls and to recognize that they were due to an animal organism (1855).

Fungi are the causes of many abnormal structures, such as cedar apples, peridermium growths on conifers, witches' brooms and other hyperplasias of various types which are so well known to botanists that it is not necessary to more than mention them at this time, although they will receive further consideration in the course of this discussion. Slime molds are the causes of some few abnormal growths; the most important being the well-known "club root" disease of cruciferous plants caused by *Plasmodiophora brassicæ* which will be referred to later.

Bacteria are recognized as the causes of such well known abnormalities as crown gall and hairy root, olive knot and legume tubercles. The first of these has received a great deal of attention in recent years because of certain resemblances to animal cancers. Crown gall attracted the attention of the European workers more than sixty years ago but the American literature contains practically no references of importance previous to 1891. Interest in this line of study received a very great impetus in 1907 when Smith and Townsend announced the discovery of the causal organism which they designated as *Bacterium tumefaciens*. The later work of these authors and of Hedgcock, Levine and others of the last quarter of a century is well known to this audience. The studies of the olive knot have been much less extensive. The legume tubercles have been the subject of extensive studies with reference to the organisms producing them and their economic value, but comparatively little attention has been given to their origin and structure. It is very well known that the abnormalities designated as "œdemas" are the results of chemical irritations; and that calluses and some other enlargements are frequently due to mechanical irritations. They have received very little attention.

Many problems have been suggested in connection with the study of plant galls. One of the earliest had to do with the nature of the irritant and has never been answered satisfactorily although centuries have elapsed since it was first proposed. Another and more recent inquiry involved the relationship of these growths, especially the crown gall, to animal cancers. Unfortunately the workers on these various groups of galls have very generally possessed but little knowledge of the other groups. It appears to the writer that it is desirable to correlate our knowledge of these various groups of galls as a basis for future study in this very interesting and important branch of botany.

We have previously stated that the old idea that insect galls were due to a chemical secretion by the mother insect is no longer accepted by the students of the subject, except possibly in the case of a few Nematus galls. Adler also showed that there was no cell division or growth until the larva emerged from the egg. Whether the very rapid growth and cell division which follows this event is due to the voracious feeding of the larva or to a chemical secreted by it is a problem which is likely to remain unsolved for some time to come. Küster is of the opinion that the excrement of the larva of *Pontania salicis* is capable of causing cell division in the host plant and this idea is supported by Cosens in his study of our American species, *P. pomum*. Both of these workers have also carried on experiments demonstrating that the larvæ of some of the Cynipidæ secrete enzymes capable of changing starch to sugar. The most generally accepted views at the present time are: (1) that the stimulus is purely mechanical; this may possibly be true sometimes, but certainly is not true in the majority of cases, (2) that the stimulus is due to a chemical action; this is more plausible in the light of modern research. However, in the case of insect galls the stimulus must come from the larva rather than from the mother insect. In the case of some insects the egg is within the tissues of the host plant and the emerging larvæ attacks the meristematic cells. In the case of some other insects the egg is placed on the surface of an incipient organ and there is no gall formation until the young insect emerges, when a more or less well defined pocket gall is produced. In this case we have no positive evidence as to whether the gall is

the result of a chemical or a mechanical irritant. However, there is undoubtedly a growth beyond the point of irritation. It is also generally believed that the stimulus endows the protoplasm with the power to develop new tissues or organs, but Cosens has advanced the more plausible theory that these new tissues and organs "are due to the awakening of dormant characters in the protoplasm." The characters are already present and the stimulus enables them to develop.

Nematodes work their way through the tissues and no doubt stimulate growth during their journeys and after coming to rest, but we do not know whether the stimulus is mechanical or chemical. However, cells not directly in contact with the organisms are stimulated to activity. Our data on galls caused by fungi with reference to this phase of the subject are very limited and unsatisfactory. It is very evident that the stimulus must be applied to meristematic cells. The ramifications of a fungus through the tissues extends the area of stimulation and development, but it also appears that cells not in contact with the fungus enlarge and divide. The slime mold, *Plasmodiophora brassicæ,* penetrates the cells, causing both cell enlargement and cell division, but in this case the neighboring cells which have not been attacked also undergo division, apparently due to some substance passing from the infected to the uninfected cells. Division also occurs in cells which are not in direct contact with the infected cells and may be due to pressure in both cases.

Galls caused by bacteria show considerable variation and may be divided into three groups as follows: (*a*) those in which the bacteria occupy small pockets and stimulate the surrounding cells, as in the case of the olive knot; (*b*) those in which the bacteria are within the cells as in the case of the legume nodule forming bacteria; (*c*) those of the crown gall type which are not well understood, although it is known that they are not in the vessels or in the intercellular spaces. Smith at first attributed the formation of the crown gall to bacterial products or toxines which escape from the infected cells. But in 1917 after successfully producing abnormalities by the use of a number of chemicals, both acid and alkaline, and also with distilled water, he came to the conclusion that "any soluble substance whatever, except a killing, a plasmolyting or an oxygen absorbing substance, if continually liberated in excess locally in tissues, would be competent to induce tumor formation." He also says "that dilute ammonia causes intumescences and have rendered it probable that ammonia liberated within the cell in small quantities by the imprisoned bacteria must be one of the causes of the excessive and abnormal cell proliferation in crown gall. Probable amin compounds also help to determine it. Since an acid and an alcohol are likewise produced by crown gall bacteria and this alcohol and this acid (as well as other acids) in pure dilution and also in combination with ammonia caused galls or intumescences in my experiments the acid (or acids), the alkalies and the alcohol must, I believe, act together in producing tumors, and *osmotically rather than chemically.*"

The reactions of host plants to parasites are many and various, but we are dealing with those which have to do with stimulations and hyperplasias. These structures appear on a great number of species of plants and are caused by organisms belonging to a very large variety of different species of animals, plants and bacteria. They are produced on all parts of the host plants and the external forms of these growths are very numerous but the histological structures are few and harmonious, regardless of the causal organisms or the species of the host plant. In fact it is doubtful if there are any new histological structures. The writer has repeatedly called attention to the fact that there are three well-defined stages in the formation of plant galls: (1) cell enlargement or cell division or both, (2) the failure of the affected part to differentiate into the characteristic tissues of the normal plant organ on which the gall is formed, and (3) the differentiation into the characteristic tissues of the gall. The writer and others have also called attention to the fact that in the Cynipidous galls which show the most complex histological structures, the tissues are organized into four well defined concentric zones surrounding the larval chamber.

The first stage in the development of the

gall, regardless of host plant or causal organism, is cell growth—either cell enlargement or cell division or both. The result is the development of parenchyma tissue from which differentiations into other tissues may or may not arise. A number of years ago the writer called attention to the fact that plant galls caused by insects could be grouped into four classes on basis of the complexity of their structure; also that the more highly developed galls pass through all the stages represented in the simpler galls during their development. Later studies on galls due to other causes and a study of the recent papers by other workers lead me to believe that most and possibly all of the various types of plant galls can be placed in some one of the four classes just referred to regardless of causal organisms, although in some cases the distinctions are not so well defined as in the most highly developed of the insect galls. These views have been very generally confirmed by the later investigations of Cosens and Wells.

Adler as a result of his studies on the Galls of the Cynipidæ, which are the most complex, believed that the egg must be placed so that the emerging larva would feed on the cambium; otherwise it would perish and a gall would not be formed. This is probably true of the galls which he studied but is not true of the galls which are due to many other organisms.

Küster has classified galls on the basis of presence or absence of cell differentiation into two great groups: (1) *kataplasmas* or those in which the structure is undifferentiated parenchyma and (2) *prosoplasmas* in which there is a differentiation into other tissues. In the prosoplasma group we find all gradations from galls with very slight differentiation of tissues to those in which the structures are very complex. Wells calls our attention to the fact that galls caused by Rotifera, Copepoda, Nematoda, Orthoptera, Neuroptera, Coleoptera, Lepidoptera, Musidæ, Chalcidæ and Tenthrenidæ must be classed as kataplasmas; while the Acarina, Psyllidæ, Aphidiæ, Coccidæ, Itonididæ and Cynipidæ include many galls which are kataplasmas and many others which are prosoplasmas. To these may be added the galls of *Plasmodiophora brassicæ* on the Cruciferæ, which are true kataplasmas and the bacterial and fungus galls which include kataplasmas and simple prosoplasmas, and also the intumescences and callous growths which are very simple kataplasmas. When the cell growth of the plant is stimulated, we find cell enlargements or cell division or both and great reduction of intercellular spaces; in fact, these changes take place before there is any visible enlargement of the organ. In many cases, the leaf-inhabiting aphids cause abundant cell division resulting in a compact mesophyll of very small cells and sometimes a division of the palisade cells without any thickening or other abnormality of the leaf.

Since the galls which are formed as a result of animal injuries give us the greatest range for study we will give them first consideration and the other types of galls will be compared with them. Since the Rotifera and Copepoda galls are represented by one species each and both are classed as the kataplasmas we will omit them from consideration. We will also omit most of the galls caused by insects, taking only those which are necessary to demonstrate the facts. Members of the Acarina are the causes of the simplest of the leaf galls. The first effect of the attack of these organisms is increased cell division. In some cases it is followed by the development of numerous trichomes, forming the socalled Erineums, and in others by the formation of pocket galls lined with trichomes. Some of them never pass beyond the kataplasma stage while others show a slight differentiation and may be considered as the simplest of the prosoplasmas.

The members of the Aphidæ are the causes of large numbers of plant galls which are especially prominent on the foliage. They are mostly of the pocket type and originate by increased cell activity. In some cases the cells tend to form zones but without differentiation. Some of them are strictly kataplasmas while others are prosoplasmas in which there has developed a considerable amount of fibrous tissue.

The Itonididæ (Diptera) contain a larger number of species of insects which cause galls than any other group. The galls also present a much greater variety of forms than those of any other group, but none of them show as

high a degree of structural complexity as the galls of the Cynipidæ. Some of them are distinct kataplasmas while others are well developed prosoplasmas; many of them have the protective zone of sclerenchyma and the nutritive zone of parenchyma which are so characteristic of the Cynipidæ.

Species of the Cynipidæ are the makers of most of the oak and rose galls which have attracted so much attention. Some few of them are kataplasmas but most of them are highly developed prosoplasmas. They are more complex in structure and the tissues are more highly developed than the galls produced by the members of any other group of organisms. These galls originate in all cases from the most active meristematic tissues and the first stage involves very active cell division. Some of these galls never develop beyond this point and are true kataplasmas but most of them undergo very rapid differentiation resulting in the development of four well-defined zones. The innermost zone is composed of very rich parenchyma cells on which the larva feeds and is known as the nutritive zone. It is surrounded by a zone of sclerenchyma cells which is very thick in the small galls and correspondingly thin in the large galls. This is surrounded by a zone of parenchyma cells, in which fibrous structures are sometimes intermingled. It is thin in small and thick in large galls. The epidermis is the fourth and outer zone.

In recapitulation of these insect galls we can say that they all originate from the meristematic cells and are at first true kataplasmas. Many of them pass into the prosoplasma stage in which fibrous and sclerenchyma tissues are more or less prominent. In most cases the sclerenchyma is new to the organ on which the gall is produced. The fibrous tissues may or may not be new and in many cases this point is difficult to determine. In many cases I am satisfied that the fibrous tissues of the plant organs, especially the roots and stems, are merely pushed out of place by the development of other cells and that sometimes these misplaced tissues have been mistaken for new ones. So far as the writer is able to determine, insect galls never originate on mature plant organs but always during early periods of very active growth.

The literature on the nematode galls is very conflicting but it is evident that the point of excitation is less definite than in the insect galls. The writer is inclined to believe that the excitation must be restricted to tissues which are more or less meristematic and it is doubtful if the xylem tissues are ever changed except as they may be distorted by pressure exerted by the growth of other cells or possibly in some cases crushed or torn. If this interpretation is correct, these galls must be classed as kataplasmas. It also appears that the form and character of the abnormality depends largely upon the age of the root at the time of the infection and the number of individual worms attacking it.

Our knowledge of the origin, structure and development of galls due to fungi is more satisfactory than that of galls due to other causes. In the various papers on galls which are caused by fungi, the discussions have to do with the fungus rather than with its effect on the tissues of the host plant. However, it appears that the reaction is restricted to the tissues that are not highly differentiated and in most cases to those that are decidedly meristematic. Some of them are readily classed as kataplasmas while others are prosoplasmas of various degrees of complexity. The most satisfactory studies are found in the cases of the cedar and apple rust fungi, although there are some galls caused by fungi which are less complex and others which are more highly developed. Unfortunately, their structures have received very little attention. In all cases the direct modifications are mainly in the parenchyma tissues. The modifications of the fibrous structures appear to be indirect. The cedar galls have been studied by a number of investigators whose ideas are extremely divergent and confusing. Alban Stewart believes that galls of *Gymnosporangium juniperi-virginianæ* arise from axillary buds. He finds that each gall contains two fibrovascular systems, one derived from the incipient stem and the other from the leaves. The parenchyma tissues predominate and the fibro-vascular structures are dwarfed and modified. He finds practically the same condition in the galls of *G. globosum*. Reed and Crabill, who studied *G. juniperi-virginianæ* at about the same time, believe the galls arise from the

leaf but otherwise their conclusions are not materially different. They further say: "The parenchyma of the leaf is stimulated to excessive growth, the fibro-vascular system, which is close to the point of infection, becomes much contorted and branched and radiates through the forming cedar apple." Again they say: "The fibro-vascular system is a modified continuation of the fibro-vascular system of the cedar leaf. From or near the base of the cedar apple, where the vascular systems are contorted, arise many branches which extend radially almost to the cortex." This description indicates that the origin and structure of these galls are similar to those of the Cynipidous galls. In their description of the effect of the fungus on the structure of the apple leaf, they say: "The hypertrophy of the apple leaf is due almost entirely to an excessive enlargement and multiplication of the spongy parenchyma cells. These cells become elongated, stand perpendicular to the upper epidermis, and form what at first glance appears to be a continuation of the palisade layer. The palisade layer, though, always remains intact and its cells, which are much smaller and more uniform in size and shape than those of the hypertrophied spongy parenchyma, are only slightly if at all enlarged. The intercellular spaces of the spongy parenchyma are entirely obliterated." This description is in harmony with that of the simple galls or kataplasmas which are due to insects. The writer has studied a number of other plant galls due to fungi and has found them to conform quite well in origin, development and structure to galls in general. Some of them are true kataplasmas while others are prosoplasmas. However, much work is necessary before it will be possible to classify these galls in their true morphological relationship.

The galls caused by *Plasmodiophora brassicæ* have been the subject of considerable research in recent years by Lutman, Chupp and Kunkel and the data concerning their development and structure is much more accurate than that of the fungous galls. They are true kataplasmas and it is evident that the cortex of the host reacts to the organism, that the cambium is especially susceptible, and that the cells of the medullary rays between the xylem also respond to the stimulus. The organism is sometimes found in the xylem but has very little if any effect upon it. The distortions of the xylem are evidently due to the force exerted by the infected rays and other parts. Instead of increasing the amount of woody tissue the action of the organism on the cambium tends to prevent the formation of vascular elements.

The bacterial galls so far as studied must be classed as kataplasmas, or possibly in some cases very low forms of prosoplasmas. The tubercles formed on the roots of the leguminous plants due to the action of *Bacillus radicicola* appear to originate and develop in the cambium of the cortical tissue and are true kataplasma galls. The so-called olive knot appears to be a true kataplasma originating in or very near the cambium, but the literature is indefinite on this point. The crown galls have received more attention than any other of the bacterial galls in recent years. The studies up to date indicate that all meristematic cells react to this organism but the character of the galls evidently depends largely on the activity of these cells at time of infection. The cells divide rapidly and therefore are very small as in galls due to other causes, more especially those in which the organism acts on the cambium of the host. It is very evident that in the formation of the crown gall, the irritant must be in the tissues which are more or less meristematic. Smith found that the dormant and old, hard, slow growing tissues were unfavorable for inoculation; but that when he used young, rapidly growing organs, he obtained good results; sometimes 100 per cent. infection. He also found that shallow inoculations into the cork cambium gave small galls while inoculations into the region of the true cambium gave vigorous tumors. The writer is inclined to believe that the size and character of the gall depend largely on the tissues infected and that the xylem seldom if ever reacts to stimulation from *B. tumefaciens*, although it is very possible that the sheath cells do respond to stimulation. The most complex and definite galls arise from the cambium, the less complex galls may arise from other meristematic tissues. The development of rather weak fibrous tissues in the galls indicates that the

crown gall is a low type of prosoplasma. However, there is much greater variation in the amount of fibrous tissue in different crown galls than in more highly developed galls due to other causes. The crown gall agrees very generally in its origin, development and mature structure with other plant galls regardless of the causal organism. However, there is certainly one and possibly three marked differences between some of the bacterial galls and galls due to other causes: (1) The presence of the tumor strands in the crown gall, (2) Possibly the stimuli in the bacterial galls are more prolonged or more variable in location than in galls due to other causes, (3) The formation of embryomas or tumor containing leaf shoots or roots which have been attributed to the crown gall. The first appears to be a very clear and well-defined feature of crown gall but not of other types of bacterial galls; the second and third are open to question and should receive further study. In considering the second point we must call attention to the fact that a gall passes through periods of youth, maturity and old age, the same as any organism or organ of a normal plant. In some species, the period of stimulation is short and in others it is very long. In discussing the third we must call attention to the tendency of most of our higher plants to produce buds and shoots in or near the nodes when stimulated or injured. Furthermore, abnormally large fruits are frequently formed as a result of decortication of the stems. It is well known that similar conditions may arise as a result of winter injury, insect and fungous injuries. One of the most striking is the formation of aerial tubers on potato plants as a result of attacks of *Rhizoctonia solani*. In all these cases the conditions appear to be due to a physiological disturbance, which interferes with the descent of elaborated foods through the phloem and cortex. The question naturally arises as to whether the pathologic conditions arising from the injuries referred to above are comparable to the pathologic conditions arising from infection with *B. tumefaciens*. That is, are excessive shoot growths following injuries, enlarged fruits following decortications and other injuries, aerial tubers following attacks of *Rhizoctonia solani* comparable to embryomas following inoculations with *B. tumefaciens*?

In answer to a series of questions by the writer, Dr. Smith defined embryomas as "crown galls containing aborted shoots, often in great numbers," and stated that they differed from aerial tubers on potatoes resulting from attacks of *R. solani* in "that the aerial shoots from these aerial tubers have no disoriented tumor tissues in them and come from normal situations, *i. e.*, from eyes, while the crown gall shoots are adventitious." He also stated that the shoots which resulted from inoculations with *B. tumefaciens* do not differ from shoots which arise as a result of other injuries, except that the tumor tissues mingle with them and that as the tumor tissues grow the shoots are injured and aborted.

Levine after working with the crown gall on *Bryophyllum calycinum* says that the leafy shoots do not occur until after the galls are established; that *B. tumefaciens* is not the cause of the formation of the leafy shoots but inhibits and retards normal development. In brief the formation of the leafy shoot is mechanical and secondary to the formation of the gall. This idea is in harmony with the prevailing opinion concerning the formation of aerial tubers on the potato plants following attacks of *R. solani*. In this connection we must take into consideration that the production of buds where they do not normally occur as a result of stimulation by *Plasmodiophora brassicæ* has been reported by Woronin, Favorsi and Kunkel. The latter author says: "The tissues of such buds are always infected. In most cases they grow into short fleshy shoots. The leaves are thick, distorted and abnormally succulent. In other cases the buds grow and give rise to sprouts of considerable size. Such sprouts may push above the surface of the ground and become green. One interesting thing shown by the diseased buds is that they are often unable to respond normally to gravity. Sometimes they arise on the under side of a root and grow directly downward. In other cases they arise laterally and turn downward like the young sprout. They have also been observed to grow out horizontally, but this is not common as downward growth." However, the fungous, slime mold and bacterial galls differ from the more highly developed insect galls in that in the case of the more complex insect galls the development

ceases very suddenly with the maturity of the larva while in the case of the other galls there is no such sharp and well-defined cessation of cell activity.

In this discussion the writer has repeatedly called attention to the fact that all galls originate in practically the same manner regardless of the stimulus which excites their growth; that although some are more complex than others, the complex types pass through the stages found in the lower forms. This very naturally leads us to look for the key for our interpretation. This subject has been discussed in an interesting paper by Wells who takes as the foundation of his studies the following statement by the writer: "The morphological character of the gall depends upon the genus of the insect producing it rather than upon the plant on which it is produced. The families show parallel lines of development from a low form to a high form." This statement was published twenty years ago and attracted more attention in Europe than in America, because the workers of Europe have given much more attention to the anatomy of pathologic plant structures than the workers in America.

Wells takes Beyerinck's division of galls into indefinite and definite growths, which was advanced in 1877, and amplified by Küster in 1911 into kataplasmas and prosoplasmas and presents phylogenetic lines of development which are very suggestive. The results of his studies reaffirm the following statements of the writer as published nearly twenty years ago: "(1) Within each family we find certain morphological resemblances, (2) The families show parallel lines of gall structure to a high form." Wells's studies reaffirm the idea expressed by the writer that all galls originate with the excessive development of parenchyma tissue. His studies may be summarized as follows: (1) He accepts Küster's groupings into kataplasmas and prosoplasmas as the basis of his work. (2) He points out that prosoplasmas have arisen from the kataplasmas by evolutionary processes. (3) Kataplasmic evolution is the result of progressive inhibition of differentiation ending with tissue homogeneity. Prosoplasmic evolution begins when homogeneity has been attained, and is the development of new tissue characters.

The most important facts in gall formation may be summarized as follows:

(1) The original theory that insect galls were formed as a result of a chemical injected by the mother insect was disproved many years ago.

(2) In most cases the stimulus is probably due to an excretion by the organism; in the case of insects, by the larva. In some cases the stimulus may be due to pressure or other mechanical factors.

(3) The stimulus must be applied to the meristematic tissues. The reaction depends largely on the degree of activity of the meristematic tissue.

(4) The reaction of cells to the stimuli is remarkably similar regardless of the stimulating factor involved.

(5) Cells that are well advanced and that under normal conditions undergo very little division may respond to the stimulation, divide and grow rapidly.

(6) Galls of indefinite and irregular form and structure may arise from older tissues which still retain some meristematic power. This appears to depend somewhat on the age and activity of the meristematic tissue.

(7) Galls may be classified in one of two groups regardless of the causal organism. The kataplasma group consists of galls which are made up of parenchyma tissue. In the prosoplasma group, the tissues have reached varying degrees of differentiation.

(8) Complex galls, such as those due to the Cynipidæ, always arise from very young and very active meristematic tissue.

(9) Galls of complex structure pass through the stages found in the galls of less complexity.

(10) Insect galls have by far the greatest regularity of structure and development. Some of them are very simple while others present the highest development and greatest complexity of any of the plant galls.

(11) The most complex insect galls show four stages of growth; others pass through one, two or three stages of development.

(12) The organism causing the insect gall is stationary but in the case of most other galls the causal organism may pass by processes of growth or otherwise to points other than their original location.

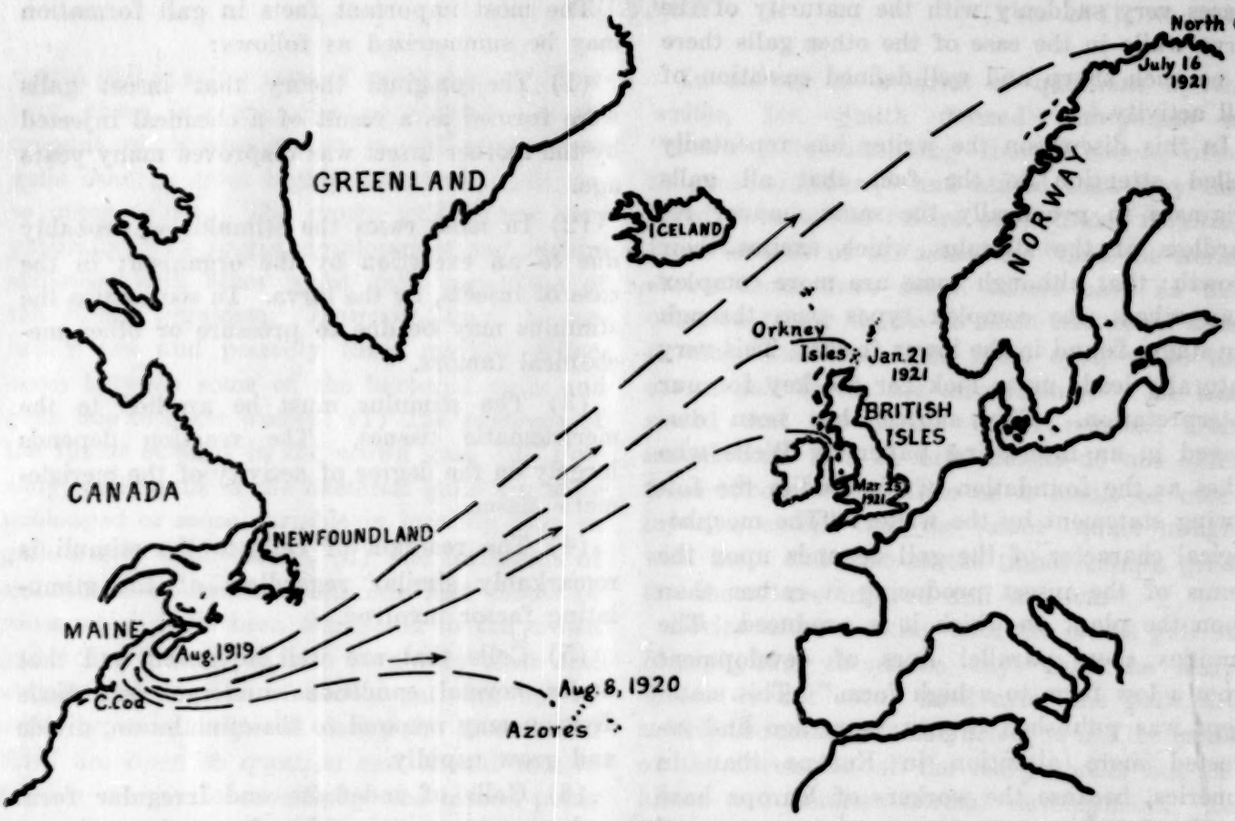

FIGURE 1. Chart on Mercator's projection of the positions of setting out and finding of drift bottles in the North Atlantic, 1919-21.

(13) The stimulus in all cases may pass beyond the location of the causal organism.

(14) Abnormal shoots and other growths (sometimes referred to as embryomas) are frequently formed in connection with many galls. Their status can not be determined from our present knowledge of the subject.

MELVILLE T. COOK

NEW BRUNSWICK, N. J.

THE COURSE OF THE GULF STREAM IN 1919-21 AS SHOWN BY DRIFT BOTTLES

IN several short notes published in this journal,[1] the writer has recorded the results of drift bottle experiments conducted for the Biological Board of Canada. Since the publication of these notes additional data has been obtained and it seems advisable to bring together to date that part of the data which bears on the course and rate of flow of the North Atlantic Wind Drift, the so-called Gulf Stream.

During the summer of 1919 some four hundred bottles were set adrift in the Bay of Fundy. Each bottle contained a postcard offering a reward to the finder who wrote in the spaces provided on the card the answers to the questions, "Where found? When found? By whom found?" Up to the present time no records have been received of bottles being found south of the Cape Cod peninsula. The records of the seventy-three bottles which were found on this side of the Atlantic during the year 1919 have already been published[2]. Four of the bottles have been found on the European side of the Atlantic. They were set adrift in the latter part of August, 1919, and the records of the finding of them follow:

No. 198. Azores, Island of Flores, August 8, 1920.

No. 230. Orkney Islands, Island of Papa Westray, January 21, 1921.

[1] Science, N. S., Vol. LII, No. 1349, page 442, November 5, 1920, Vol. LIII, No. 1365, page 187, February 25, 1921, Vol. LIII, No. 1373, page 289, April 22.

[2] Proceedings of the American Fisheries Society, 1920, page 334. Contributions to Canadian Biology, New Series, Vol. I, No. 8, page 103, 1922.

No. 98. Great Britain, Dyffryn, North Wales, March 25, 1921.

No. 129. Norway, two miles from land at the Böhle-Walstation, Sorö, Westfinmark, July 16, 1921.

The places referred to are shown in the accompanying chart, figure 1.

Considerable information as to the course and rate of flow of the North Atlantic Wind Drift or Gulf Stream during the winter of 1919-20 and the summer of 1920 is to be obtained from the finding of these bottles. The distances which they must have been carried, measured along the shortest courses which they could have taken, are approximately 2000, 2800, 2900 and 3800 geographical miles. The corresponding lengths of time which the bottles were "out" are 12, 17, 19, 23 months respectively. This close correspondence between the distances traveled and the times the bottles were "out" indicates that the bottles were picked up relatively soon after they reached the coast. If this assumption is justified the average rates at which the bottles moved across the North Atlantic were 5.8, 5.4, 5.1, and 5.5 geographical miles per day.

The success of this experiment carried out on a comparatively small scale—only four hundred bottles were used and they were all set out within thirty miles of the shore—indicates that important and far reaching results in the investigation of ocean currents are to be obtained from the use of drift bottles. Such experiments can be carried out at small expense. Since the bottles can be set out from any vessel while under way, practically the total cost of an experiment is that of the bottles and the rewards offered to those who find them.

JAMES W. MAVOR.

UNION COLLEGE.

SCIENTIFIC EVENTS

THE PREPARATION OF STAINING SOLUTIONS

IN the text-books dealing with microscopy and with bacteriology, as well as in the journal literature dealing with these subjects, there are two general types of stain formulæ. In one type of formula so much dry stain in weight per given volume of solution is called for, in the other type so many cubic centimeters of a saturated solution of the stain. It will be readily seen that the same staining formula could be prepared by both methods provided the solubility of the dry stain and its actual dye content were known. If all batches of dry stain contained the same amount of actual dye either sort of formula would be perfectly satisfactory.

Unfortunately, however, different lots of any stain vary greatly in the amount of inert material they contain. This is true even in regard to different batches of Grübler stains and it is especially true now when there are so many different brands of stains on the market. An investigation of certain methylen blues, for example, showed a Grübler sample examined to contain 57 per cent. of actual dye, a Merck sample 55 per cent., while five different American samples varied from 69 per cent. to 88 per cent. It seems in general desirable that the color strength should be as high as reasonably possible, and it must be particularly pointed out that the sample containing 88 per cent dye proved one of the two very best in a long series of methylen blues examined. It is obvious, however, that a staining formula calling for so many grams of Grübler methylen blue will be more concentrated if made up with one of these American stains. Considering how these stains vary in actual dye strength, much more nearly constant formulæ can be obtained provided they are prepared on the basis of a definite volume of a saturated solution. Although there are undoubtedly some differences in the amount of actual dye and goes into solution in the case of different brands of stains, nevertheless the results are much more constant in this case than when the formulæ are prepared on the basis of weight of dry dye. For this reason biologists publishing stain formulæ are urged to cooperate with the committee in putting the formulæ on the basis of so many cubic centimeters of saturated solution. The saturated solution may be either aqueous or alcoholic, according to the needs of the individual case. Objections are sometimes made to this type of formula in that it is difficult to prepare without waste when the solubility of a stain is not known. This is not a valid objection, however, because a saturated solution of any stain can

always be kept on hand with an excess of undissolved material at the bottom of the bottle, adding more water or alcohol from time to time as more stock solution is needed in preparing staining solutions. This type of formula, therefore, has so many advantages without serious disadvantages that its use is recommended in all possible cases.

H. J. CONN,
Chairman, Commission on the Standardization of Biological Stains

SYMPOSIUM ON MATERIALS OF CHEMICAL EQUIPMENT CONSTRUCTION

MANY prominent chemists have suggested from time to time that a symposium should be held upon the subject relating to materials as applied to construction and equipment in the industry. Therefore, at the spring meeting of the American Chemical Society, it has been decided to hold a symposium entitled "Materials of Chemical Equipment Construction."

The literature upon this subject is so widely scattered and published in many journals inaccessible to the average chemist that in many cases much time must be spent in duplicating work which has already been done. The symposium will tend to bring together such matter for which chemists are constantly in search.

The officers of the Industrial Division have been particularly fortunate in securing Mr. Philip A. Singer, of the Singer-Perlstein Company, Chicago, Ill., to act as chairman of this symposium. Mr. Singer was graduated from Bradley Technical Institute in 1899 and then he pursued graduate work at the University of Heidelberg, Germany. He then returned to this country as chemist for the Glucose Sugar Refining Company, now the Corn Products Company, and became their plant manager and superintendent. Later he became manager of the Standard Alcohol Company, of Fullerton, La. A few years later he became superintendent of the Piel Brothers Starch Works at Indianapolis. While in the last two positions he was also employed in a consulting capacity by the Chicago Starch Works and the Industrial Chemical Institute of Milwaukee. For the last seven years he has been a consulting engineer on the subject of starches, dextrin, glucose and allied subjects. Mr. Singer not only does the engineering work, that is, designs the complete plant, but also superintends the construction and actually operates the plant until it has been put on a practical operating basis.

The subject matter of the symposium will cover woods, metals, vitreous materials, coatings, rubber fabrics, etc. All of these headings will deal with the resisting properties of acids and alkalies, their resistance to temperature, oxidation characteristics, cost, chemical composition, etc.

It is hoped that industrial chemists and university professors will cooperate in every possible way with Mr. Singer by writing to him directly, stating on what phase of the subject they would be glad to present papers at the New Haven meeting.

ERLE M. BILLINGS,
Secretary Industrial Division

TEN-YEAR PROGRAM OF THE NEW YORK AGRICULTURAL EXPERIMENT STATION

IN order that the New York Agricultural Experiment Station may serve satisfactorily the agricultural interests of the state and nation, Dr. R. W. Thatcher, director of the station, and his associates have formulated a program for the development of the work at Geneva for the next ten years. The program has been endorsed by all the organized agricultural agencies of the state and is to be presented to Governor-elect Smith and the new legislature for their consideration. It is believed that only with the aid of a definite program can funds be intelligently appropriated for the work of the station and the affairs of the institution satisfactorily administered. The program provides for the further development of present lines of research and for the inauguration of several new lines of work not now receiving attention.

Activities which the station authorities are anxious to develop further or to undertake as new projects are the breeding and testing of new varieties of small fruits and vegetables, particularly for canning; investigations into the manufacture and preservation of fruit juices, drying of fruits and vegetables, and the utilization of cull fruits and vegetables for

jellies, glues and coloring matters; chemical and bacteriological studies of milk and its products; soil tillage studies with special reference to the movement and utilization of soil moisture; studies in plant physiology; investigation of the effect of climatic factors upon plant growth; and careful observations on the relation of birds to agriculture. It is also hoped to study further the efficient use of farm crops for both human and animal food.

"It is not expected to put all of this program into effect at any one time, but to develop it gradually as circumstances permit," says Dr. Thatcher. "The first consideration in carrying out the program, however, is increased laboratory space, as the present laboratories are already overcrowded and will not permit of any expansion of the work. The immediate provision of a new laboratory building is essential if the research work of the station is to progress as it should. The people of the state are asked to back a campaign in the legislature for this building and program, because it is certain that the necessary expenditure will be returned to the state many times over in the increased wealth and prosperity of its agricultural population."

THE CENTENARY OF PASTEUR'S BIRTH

FRANCE'S homage to Louis Pasteur, on the occasion of the centenary of his birth, began on December 24 with a ceremony in the Pasteur Institute. Delegations from scientific bodies, headed by Dr. Pierre Roux and Dr. A. C. Calmette, of the Pasteur Institute, marched in procession before the tomb of Pasteur, which is a crypt in the institute. Afterward Dr. Pozerski of the institute delivered a lecture on Pasteur's life and work.

On December 26 the centenary was observed by the Paris Academy of Medicine, when addresses were made by Professor Behal, president of the academy, and Dr. Calmette, of the Pasteur Institute.

Numerous celebrations were held in France and throughout the world on December 27. Cardinal Dubois celebrated mass in the Paris church where Pasteur worshipped. Pasteur's daughter, Mrs. Valery Radot, and her husband and son were present. President Millerand presided over a memorial ceremony at the Pasteur Institute, where Dr. Pierre Roux, director of the institute, delivered the address.

In this country there were special exercises in Philadelphia on December 27, the principal addresses being made by Ambassador Jusserand and Dr. Hugh S. Cumming, surgeon-general, U. S. Public Health Service. Messages of appreciation were read from President Harding, Mr. Wilson, Chief Justice Taft and many others.

At the American Museum of Natural History in New York there was a meeting at which Dr. George F. Kunz, president of the New York Mineralogical Club, presided. The speakers were M. Gaston Liebert, French consul general; Dr. Henry Fairfield Osborn, president of the American Museum of Natural History; Dr. Hermann M. Biggs, state health commissioner; Dr. George D. Stewart, president of the New York Academy of Medicine; Dr. Pierre Lecomte du Nouy and Dr. Hideyo Noguchi, of the Rockefeller Institute; Major Henry J. Nichols, United States Army, and Professor C.-E. A. Winslow, of Yale University.

The Federation of American Societies for Experimental Biology, meeting at Toronto, arranged a dinner at which addresses were given by Professor Graham Lusk, of the Cornell Medical School, and Professor F. G. Novy, of the University of Michigan.

The centenary is being celebrated by the New Academy of Medicine. A public exhibition which opened on December 27 will continue until January 10. It includes books, portraits, statues, medallions and other objects intimately connected with Pasteur and his work. Commemorative exercises will be conducted in the Academy of Medicine on the evening of January 10.

SCIENTIFIC NOTES AND NEWS

A SPECIAL number of SCIENCE containing the address of the retiring president of the American Association for the Advancement of Science and the proceedings of the association, of the sections and of the affiliated national scientific societies meeting at Boston during convocation week will be issued next week, or as soon thereafter as the material can be col-

lected and edited by the permanent secretary of the association.

DR. CHARLES D. WALCOTT, secretary of the Smithsonian Institution and president of the National Academy of Sciences, formerly director of the United States Geological Survey, has been elected president of the American Association for the Advancement of Science.

PROFESSOR B. M. DUGGAR, of Washington University, has been elected president of the Botanical Society of America; Dr. J. R. Schramm, of the division of biology of the National Research Council, vice-president; Professor I. F. Lewis, of the University of Virginia, secretary, and Professor I. W. Bailey, of Harvard University and the Bussey Institution, treasurer.

PROFESSOR T. D. A. COCKERELL, of the University of Colorado, was elected president of the Entomological Society of America at the Boston meeting. Professor William S. Marshall, of the University of Wisconsin, was chosen first vice-president; F. E. Lutz, of the American Museum of Natural History, New York City, second vice-president; C. L. Metcalf, of the University of Illinois, secretary-treasurer; and Professor Herbert Osborn, of the Ohio State University, managing editor of the annals.

AT the meeting of the American Psychological Association held at Harvard University last week, Professor Lewis M. Terman, of Stanford University, was elected president and Dr. John E. Anderson, of the Johns Hopkins University, secretary.

THE government of Japan has granted to Dr. David Starr Jordan the decoration of the "Order of the Rising Sun with a double series of rays" as "an expression of the nation's recognition and gratitude for the useful and unselfish services rendered for its sake." The decoration was presented through President Kozai and Professor Watasè of the Imperial University of Tokyo.

A DINNER in honor of Professor E. L. Mark, of Harvard University, who was seventy-five years old last May, and was recently retired with the title of Hersey professor of anatomy, emeritus, was given in Boston on December 27.

FRIENDS of Professor Charles Frederick Chandler, of Columbia University, presented in 1910 to the university a sum of money which constitutes the Charles Frederick Chandler Foundation. The income from this fund is used to provide a lecture by an eminent chemist and a medal to be presented to the lecturer in recognition of his achievements in science. The lecturer this year is Robert Eckles Swain, professor of chemistry and head of the department of chemistry of Stanford University, who will speak in Havemeyer Hall on "Atmospheric pollution by industrial wastes" on January 9.

DR. PERCY BROWN, roentgenologist at the Jackson Clinic, Madison, Wis., was awarded the gold medal of the Roentgenological Society of North America at its recent meeting in Detroit. Dr. Brown was formerly president of the society and received the medal because of his distinguished scientific research in X-ray diagnosis and therapy. The medal has been awarded to Madame Curie, of Paris; Dr. Gosta Forsell, of Stockholm, and Dr. Maude Slye, of Chicago.

SIR WILLIAM H. BRAGG, Quain professor of physics in the University of London, has been elected a corresponding member of the Paris Academy of Sciences in the section of physics.

SIR SIDNEY F. HARMER, director of the natural history departments of the British Museum, has been elected an honorary fellow of King's College, Cambridge.

THE Italo-American Association of Rome gave a farewell reception on December 21 in honor of William Marconi, who left on December 22 for the United States. The reception also was in celebration of the twentieth anniversary of the uniting of the United States and Europe by wireless telegraphy. Senator Maggiorno Ferraris made an address of welcome, to which Mr. Marconi responded, saying that his association with the United States had been close and continuous from the time of the commencement of his work on radio telegraphy.

THE war department awarded on December 5 the distinguished service medal to Joaquin E. Zanetti, lieutenant colonel of the Chemical Warfare Service, U. S. A, "for exceptionally

meritorious and distinguished services as chief liaison officer of the Chemical Warfare Service with the French forces. His untiring energy, thorough familiarity with the French language and methods and his superior technical ability enabled him to gather an enormous amount of detailed information concerning the manufacture, handling and use of gases, which were of inestimable value to our government in the manufacture and supply of chemical warfare materials in the United States." The presentation was made by Major General Bullard at Governor's Island, N. Y., on December 21.

THE friends of Amos W. Butler on December 20 in Indianapolis tendered him a dinner to celebrate his notable success during twenty-five years as secretary of the State Board of Charities. About two hundred and fifty were in attendance. Addresses were made by Governor Warren T. McCray, Dean C. H. Eigenmann, Dr. S. E. Smith, Dean Stanley Coulter and Alexander Johnson, first secretary of the Indiana Board of State Charities. Mr. Butler organized the Brookville Society of Natural History, which in 1885 gave birth to the Indiana Academy of Science, of which he was for many years the executive secretary and president. He has been an active member of other Indiana associations and is at present president of the Indiana Historical Society.

AT the annual meeting of the Academy of Natural Sciences of Philadelphia held December 19, John Cadwalader, LL.D., retired from the presidency, which he had occupied since 1918. The following officers, councilors and elective committees were elected to serve for the year 1923: *President,* Richard A. F. Penrose, Jr., Ph.D.; *vice-presidents,* Edwin G. Conklin, Ph.D., Henry Skinner, M.D., Sc.D.; *recording secretary,* James A. G. Rehn; *corresponding secretary,* J. Percy Moore, Ph.D.; *treasurer,* George Vaux, Jr.; *librarian,* Spencer Trotter, M.D.; *curators,* Witmer Stone, Sc.D., Henry A. Pilsbry, Sc.D., George L. Harrison, Jr., T. Chalkley Palmer; *councilors to serve three years,* John Cadwalader, LL.D., Robert G. LeConte, M.D., Milton J. Greenman, M.D., Morgan Hebard; *councilors to serve unexpired terms,* Thomas S. Gates, Henry Tucker, M.D.; *committee on accounts,* Roswell C. Williams, Jr., Samuel N. Rhoads, John G. Rothermel, Thomas S. Stewart, M.D., Walter Horstmann.

AT the annual meeting of the American Social Hygiene Association, held in New York on November 3, under the presidency of Dr. Hermann M. Biggs, the following officers were elected for the ensuing year: *President,* Dr. Hermann M. Biggs, New York City; *vice-presidents,* Drs. Ray Lyman Wilbur, San Francisco, Dr. William S. Keller, Cincinnati, Dr. William A. Evans, Chicago, and Mrs. Joseph T. Bowen; *secretary,* Dr. Donald R. Hooker, of the Johns Hopkins University. It was announced that the *Journal of Social Hygiene* will appear, January, 1923, as a monthly, the new publication taking the place of the *Social Hygiene Bulletin.* Professor Maurice A. Bigelow, of Teachers College, Columbia University, is editor-in-chief of the new journal.

PROFESSOR O. F. STAFFORD, head of the department of chemistry of the University of Oregon, has returned to his university work at Eugene, after a leave of absence of four years' duration devoted to industrial research in the field of waste wood utilization by destructive distillation.

CARL G. SCHLUEDERBERG, president of the American Electrochemical Society, left recently for a four months' trip in the Orient to study business conditions.

PROFESSOR H. S. FAWCETT, of the Citrus Experiment Station of the University of California, is spending a sabbatical year in southeastern Russia. He is engaged in relief work of the American Friends Committee at Sorochinskya. He expects to return in the summer of 1923.

DR. WALTER ROSENHAIN, head of the metallurgical department of the British National Physical Laboratory, will visit the eastern United States during February and March, 1923, lecturing before various universities and scientific organizations.

THE annual Gross lecture for 1922 of the Pathological Society of Philadelphia has been delivered by Professor Warren H. Lewis, of the Department of Embryology of the Carnegie Institution, on "Pathological changes in cells in tissue cultures."

PROFESSOR JOHN HUNTER, of the University of Sydney, Australia, lectured recently at the Evans Institute of the University of Pennsylvania on "The evolution of the brain in the light of modern discoveries."

PROFESSOR SUMMERFELD is to spend two weeks at the California Institute of Technology beginning January 24. He will deliver eight lectures covering the following topics: Quantic conditions, especially for more than one moving particle; Atomic structure and periodical system; Quantization in space, theory of magneton; Principles of selection in the visible and the X-ray part of the spectrum; Line structure of complicated spectra treated by the method of inner quantic numbers.

BEFORE the Franklin Institute on December 20 Dr. W. F. G. Swann, professor of physics, University of Minnesota, lectured on "Unsolved problems of cosmical physics."

THE fourth Harvey Society lecture which was to have been delivered at the New York Academy of Medicine on January 13, by Dr. William T. Bovié, assistant professor of biophysics, Harvard University, on "The physiological effects of light rays," has been postponed until January 20.

A CONVOCATION commemorative of the births of Mendel and Pasteur was held at St. Louis University on the evening of December 14. After introductory addresses by Chancellor Frederic A. Hall of Washington University and Professor Frederick M. Tisdel, dean of the College of Arts and Sciences of the University of Missouri, who represented President John Carleton Jones, the main addresses of the evening were delivered by Professor H. S. Jennings, on "Mendel, the Scientist," and Professor Victor C. Vaughan, "Pasteur, the Scientist." The exercises were concluded by the presiding officer, President William F. Robison, with an address, "Science and the Man."

WE learn from *Nature* that a memorial window in Westminster Abbey in remembrance of Sir J. W. Wolfe Barry, past president of the Institution of Civil Engineers, was dedicated on December 7 by the dean of Westminster. The window, which is in the nave, contains the figures of two angels holding tablets on which are inscribed the words "In Memory of John Wolfe Barry, K.C.B., F.R.S., Civil Engineer. Born 1836. Died 1918." Below the tablets are shields showing, among others, the arms of the Institution of Civil Engineers, of the University of London, and Sir John Wolfe Barry's personal arms.

A STATUE of Professor Adolf von Baeyer was unveiled in the Botanic Garden of the University of Munich on October 20. Professor Willstätter spoke on behalf of the university, and Dr. Duisberg on behalf of the Association of Dye Manufacturers, Professor Seeliger for the Bavarian Academy of Sciences and Dr. Lepsius for the German Chemical Society.

THE international fund in honor of Lord Lister has been closed, the amount received being sufficient to provide a prize of £2,800 (about $13,000), to be awarded triennially for the most important advancement made in surgery, irrespective of nationality. This prize will be awarded on the anniversary of Lord Lister's birth.

DAVID LINDSAY, the explorer, whose pioneer investigations were in part responsible for the discovery of the great West Australia gold field, died recently in Australia at the age of 66 years.

THE death is announced of Dr. H. Obersteiner, professor emeritus of the physiology and pathology of the central nervous system at the University of Vienna, aged seventy-five years.

AN Associated Press dispatch from Paris states that the first sub-committee of the League of Nations Intellectual Cooperation Commission, presided over by Professor Henri Louis Bergson, which has had under discussion the question of the extension of the rights of scientists so that they may be able to share in the benefits derived from the application of their discoveries, has concluded its work. Professor Ruffini, of Turin University, was commissioned to draft a plan for the legal protection of scientific work. After approval by the commission and the council of the League of Nations the plan would serve as a basis for legislation by parliaments of the different countries of the world.

THE annual general meeting of the Amer-

ican Philosophical Society will be held on April 19, 20 and 21, beginning at 2 P.M. on Thursday. Members are requested to send to the secretaries, at as early a date as practicable and before February 22, 1923, the titles of papers which they intend to present, so that they may be announced in the *preliminary* program which will be issued immediately after that date and which will give in detail the arrangements for the meeting. It is understood that papers offered are original contributions which have not been theretofore presented. The publication committee, under the rules of the society, will arrange for the immediate publication of the papers presented in either the *Proceedings* or the *Transactions,* as may be designated.

THE first regular meeting of the Georgia Academy of Sciences was held at the University of Georgia on December 1 and 2, 1922. Twenty-five members were elected as charter members and fifteen more may be elected during the coming year. Membership in the academy is limited to those residents of Georgia who have made notable contributions to science or to its advancement in the state and can not exceed fifty in number. The officers elected for the first year are: *President,* Dr. R. P. Stephens, mathematics, University of Georgia; *vice-president,* Dr. T. P. Branch, civil engineering, Georgia School of Technology, Atlanta; *secretary-treasurer,* Dr. Henry Fox, biology, Mercer University, Macon.

THE Rochester Section of the American Chemical Society has secured Professor Th. Svedberg, University of Upsala, Sweden, to act as presiding officer of a symposium on physical chemistry which will be held in Rochester on January 19 and 20. Papers will be presented by prominent physical chemists from Schenectady, Cornell, Syracuse, Buffalo and Rochester. Practically every phase of physical chemistry will be dealt with, with the exception of colloids. On this phase there will be no papers since a colloid symposium will be held at the University of Wisconsin later in the year. The Rochester Section extends an invitation to those interested in this physical chemistry symposium to be present and to take part either in the presentation of papers, or in the discussion which will follow the papers.

THE annual meeting of the British Association of Economic Biologists was opened in the Botanical Department of the University of Manchester on December 15. Dr. W. Lawrence Balls introduced a discussion on genetics in relation to applied biology. After dinner there were informal discussions on the place of applied biology in universities and on the relation of biology to medicine. A visit was paid to the British Cotton Industry Research Association at Didsbury.

AN expedition for zoological exploration will be maintained in Honduras and British Honduras by the Field Museum of Natural History in the early months of 1923. Mr. Karl P. Schmidt, assistant curator of reptiles and amphibians, accompanied by Mr. L. L. Walters, taxidermist, will leave New Orleans in January for Belize, British Honduras. After a short stay in the coastal region of British Honduras, in the nature of a reconnaissance, the party will proceed to Honduras, establishing a base at Lake Yojoa, in the interior. Collections of fishes, amphibians, reptiles and mammals will be made in this little known region. The fishes of Lake Yojoa appear to be entirely unknown. It is planned to secure material which will enable the Department of Zoology to prepare specimens and habitat groups for exhibition, representing the rich and varied amphibian and reptile life of Central America.

THE Edible Gelatin Manufacturers of America, Incorporated, announces the establishment of an industrial fellowship in the Mellon Institute of Industrial Research of the University of Pittsburgh, for the purpose of ascertaining the real food value of edible gelatin in its manifold applications in the American dietary. In addition to experimental investigations, a correlation of available facts regarding edible gelatin will be made, to be held at the disposal of all users. The present incumbent is Dr. Thomas B. Downey, who will be glad to furnish information to those interested in the uses of edible gelatin.

REPRESENTATIVE CABLE, of Ohio, has offered a resolution in the House, requiring the use with immigrants of the "intelligence tests" used by the army. The resolution has the approval of the house committee on immigra-

tion, and the indications are that experiments will be made to find out whether the proposed system is superior to the tests now used. The resolution sets forth that intelligence tests have been given to soldiers of the United States during and since the World War; applied by the United States Public Health Service to a limited number of immigrants of doubtful admission; used by the United States in civil service examinations; in schools, colleges and universities in classifying pupils and students; by insurance and other large companies in selecting salesmen; in large industries for classifying men in work most adaptable to them, and by business enterprises in the selection of office forces. Students of the problems relating to immigration have indicated a belief that the standard of immigrants seeking admission to the United States may be raised by the application of the intelligence tests, and the secretary of labor and the surgeon general of the United States Public Health Service have full power and authority to apply such tests. The resolution directs the secretary of labor and the surgeon general of the Public Health Service to inform the House why scientific data, including the intelligence tests, can not be applied in all cases for the exclusion of undesirable immigrants.

UNIVERSITY AND EDUCATIONAL NOTES

THE Rockefeller Foundation and the General Education Board have each given $1,250,000 to the College of Medicine of the State University of Iowa. The legislature will be asked to appropriate $2,500,000 at the rate of $450,000 a year for the building and equipment of hospitals and laboratories.

THE sum of $50,000 left by the late Charles S. Baylis reverts to the Brooklyn Polytechnic Institute by the death of Mrs. Baylis on November 15.

DR. JOSIAH H. PENNIMAN was elected provost, or the "educational or academic head" of the University of Pennsylvania, on December 27. He had been acting provost since the resignation of Dr. Edgar Fahs Smith about three years ago. At the same time the board of trustees created an "executive administrative" office, to be known as the "president of the university." This is the position that it was planned should be filled by General Leonard Wood.

D. W. MOREHOUSE, professor of physics and astronomy at Drake University, has been elected dean of the college of liberal arts.

AT Yale University, Dr. Lorande Loss Woodruff, professor of biology, has been elected professor of protozoology.

DR. MORRIS S. KHARASCH, formerly national research fellow in organic chemistry at the University of Chicago, has been appointed associate professor of organic chemistry at the University of Maryland.

DR. RICHARD C. LORD, at one time instructor at Washington and Lee University and later engaged in industrial chemistry, has been elected assistant professor of chemistry and physics at Kenyon College, Gambier, Ohio.

AT Dartmouth College, Assistant Professor R. D. Beetle has been promoted to a full professorship of mathematics, and Assistant Professor C. E. Wilder, of Northwestern University, has been appointed to an assistant professorship.

DISCUSSION AND CORRESPONDENCE

THE INDEXING OF BIOLOGICAL LITERATURE

I HAVE been much interested in Dr. Schramm's excellent discussion in SCIENCE of November 3, and since the whole subject of abstracting and indexing is up for reconsideration, it may be opportune to add a few remarks from a zoological standpoint.

It may fairly be said that American zoologists do not pay enough attention to the literature of their subject outside of the very narrow field of their specialty. In spite of the broadening tendencies of modern genetic research, we do not seem to be able to escape from a narrowness which sometimes prevents those working on one group from even being aware of the existence of distinguished colleagues specializing in another. Thus it comes about that the development of numerous special journals, necessary as these are, is actually detrimental to zoology as a whole if there is no broader survey of the field which specialists

read. Every technical monograph contains material which should be of great interest to *all* zoologists, but such works are published and go to a small number of specialists, frequently with not even a review to call the attention of a wider public. The zoologist is in danger of becoming what the Greeks called *idiotes,* one who lives to himself and has no part in the larger affairs even of zoology.

It is not important to debate whether it was always so, or whether it is so elsewhere in greater degree. The evil is a real one, and should be met in such ways as Dr. Schramm indicates.

It must be said, however, that the fault is more with the zoologists themselves than with the means devised to serve them. The *Zoological Record,* which has been regularly published since 1864, should be a *sine qua non* to every zoologist, yet comparatively few use it. It has been, especially of late, as nearly perfect as a human thing may be. From it, I can learn in half an hour what species of *any* genus of animals have been described, placed in the synonymy, or referred to in important discussions, during say the last twenty years. I can learn what species have been described from Samoa or Spain; what contributions have been made to comparative physiology or anatomy, and in short anything of importance about animals, living or fossil. Personally, I subscribe to the complete volumes; but if I do not wish to do this, I can get the whole account of Protozoa for a year for three shillings, of mollusca for five shillings, of mammals for three, and so forth. Can there be a living student of mammals who will not pay 75 cents a year to have a complete index to the literature of his subject? Incredible as it may seem, there are dozens of them! The one thing the *Zoological Record* does not do, and which should be done, is to provide readable discussions of the literature, pointing out in an interesting way the nature of the advances and estimating their importance. This, however, can not be done efficiently unless the critical element is allowed to enter, unless the discussion becomes a review and not a mere abstract.

Something should be said about the card catalogue. I maintain card catalogues of my own for particular purposes, and they are invaluable. But as a means of ready reference to zoology as a whole, or any large branch of it, cards are miserably inadequate. If I were furnished the whole contents of the *Zoological Record* on cards, I could neither find time to arrange them, nor space to take care of them. Furthermore, suppose the space and assistance provided, I could not use the catalogue with the same advantage. Thus, to ascertain the nature of the references to, say Equidæ, I should have to turn over hundreds of cards. On the pages of the *Record,* my eye runs rapidly over the assembled data, and I can cover the work of a year in a few moments. If I am concerned with some genus, on the printed page I find the related and segregated genera close at hand, and at once perceive or suspect their significance for my researches. With cards, if a species is not placed in the genus I am looking up, I almost certainly miss it altogether.

T. D. A. COCKERELL

UNIVERSITY OF COLORADO,
NOVEMBER 22

SPECIFIC TERMS FOR THE PROTEOLYTIC ACTIVITY OF ANAEROBES

IN descriptions of anærobes the term "proteolytic" is very widely used, and in classification studies this activity of the organism is of very great importance in grouping. In some schemes it is given first consideration because it is a fundamental, deep-seated physiological character. However, the term does not carry a definiteness of meaning commensurate with its importance.

For example, the Medical Research Committee (1919) in their Special Report, Series No. 39,[1] on the classification of anærobes include *C. septique* in the proteolytic group because it liquefies gelatine, while in their Special Report, Series No. 12 (1917),[2] they place

[1] Medical Research Committee. 1919 National Health Insurance. Special Report Series, No. 39. Reports of the committee upon anærobic bacteria and infections. London, pp. 182.

[2] Medical Research Committee. 1917 National Health Insurance. Special Report Series, No. 12. The classification and study of the anærobic bacteria of war wounds. London, pp. 74.

it in the non-proteolytic group on the basis of its inability to liquefy blood serum. The use of such a general term as proteolytic tends to confusion and it seemingly would have been better to have made the classification on its ability to liquefy or not liquefy gelatine or its ability to digest blood serum or not to digest it and to have used corresponding specific terms such as gelatinolytic and serolytic.

Reddish and Rettger[3] (1921) were not satisfied with the general term "proteolytic" to cover digestion of all kinds of protein and made use of this term only with some reservation. They did not designate an anærobe proteolytic on the basis of genatin-liquefying power, but reserved the term "gelatinolytic" for this property; the term "proteolytic" was used to mean the digestion of native proteins only, such as meat, egg-albumen and blood serum. They designate the breaking down of peptone as "peptolytic." It is true that gelatin and peptone are simpler than the native proteins and for that reason, perhaps, more easily attacked, so that the difference in ability of an organism to attack these without being able to digest the native protein may be one of degree and not of kind. It seems more probable, however, that it is really a difference in kind of enzyme.

It seems to the writers that specific terms should be used throughout in describing such properties of anærobes, or of any other bacteria. Since various kinds of protein are used, it might be well to use designations to fit those employed. Such terms as the following would find a place in these descriptions: sarcolytic (dissolution of flesh); peptolytic (dissolution of peptone); gelatinolytic (dissolution of gelatin); ovolytic (dissolution of egg albumen); fibrinolytic (dissolution of fibrin); etc. In no sense is the term "proteolytic" to be limited, except that it should be qualified by such of the above terms as suit the case. It might even be advisable to base classification grouping upon one or another of the specific kinds of protein used. For this purpose, meat seems to offer the greatest promise, because of the ease with which meat media can be prepared, the simplicity of the use of same, and the standard nature of the medium in anærobic work. If this were adopted, anærobes could then be designated "sarcolytic" or "non-sarcolytic," according to whether or not meat is digested. At least, such a division on the basis of specific protein attacked would be more in keeping with the scientific accuracy which is the goal in all fields of bacteriology. In medicine, the use of specific terms has been necessary to avoid complications in meaning. This should prove equally valuable in bacteriology.

E. C. L. MILLER
G. F. REDDISH
MEDICAL COLLEGE OF VIRGINIA

[3] Reddish, G. F., and Rettger, L. F.: 1921 Proc. Soc. Amer. Bact., 23rd Ann. Meeting, Philadelphia, 1921.

THE STANDARDIZATION OF BIOLOGICAL STAINS

SPECIAL attention of biologists is called to the fact that the work on standardization of stains is no longer being carried on by the National Research Council. It is a fixed policy of the council to take part in the stimulation and assistance of scientific projects in their initial stages, but to withdraw when such projects are well started in order to be able to respond to new desirable projects brought before it. For this reason it has now withdrawn from the work that is being done on stains, not because it is no longer interested in the project but because the work is now in a position to justify an independent existence.

With the assistance of the council, an independent commission has been formed composed of an indefinite number of the biologists who have been collaborating in the work. At present about sixty investigators are members of the commission. Its affairs are managed by an executive committee composed of H. J. Conn, J. A. Ambler, S. I. Kornhauser, F. W. Mallory and L. W. Sharp.

The present occasion is taken to call attention to an omission in a recent paper referring to this work.[1] In this paper the name of one concern specializing in biological stains was inadvertently omitted. This concern was formerly known as the H. S. Laboratories, and has just been reorganized under the name of

[1] "Present Supply of Biological Stains," SCIENCE, 56, No. 1455, pp. 562-3.

the Hartman-Leddon Company; its address is 6005 Girard Avenue, Philadelphia, Pa. Apologies are due to the company for the unintentional omission.

H. J. CONN,
Chairman Executive Committee, Commission on Standardization of Biological Stains
GENEVA, N. Y.
DECEMBER 1, 1922

QUOTATIONS

THE ROYAL SOCIETY

YESTERDAY being St. Andrew's Day, the fellows of the Royal Society, in accordance with their custom and duty since the middle of the seventeenth century, assembled to elect their officers and council for the ensuing year. Thereafter, in accordance with a custom more ancient than the formal granting of their charter, they reassembled in a tavern to "make merry with persons of consequence in the community." Long may it flourish and increase its influence on the affairs of the community, directly or through persons of consequence. It may be doubted if the election of fifteen new fellows annually, a wise restriction when the number was thus determined in 1847, is now sufficient, if the extension of science and of the empire since that date be considered. But it can not be doubted that the anxious care given to the selection of candidates has made the fellowship a real distinction, and the society the foremost representation of scientific opinion in the world. The more the pity that it does not use so fine a voice to its due capacity. The Royal Society should be the acknowledged adviser of the government, of the departments and of the nation on all scientific and in many educational matters. It should receive, allot and administer all state aid for scientific research and for higher scientific education. It should be the obvious channel into which private benefactions for scientific objects should be directed. In fact, the direct contacts of the Royal Society with government, with departments and with universities, have diminished rather than increased in recent years, and generous private benefactors have less often chosen it as the vehicle of their wishes. The officers and council elected yesterday are men of the highest distinction; let it be hoped that they will take steps towards re-acquiring and increasing the direct influence and authority of the chief scientific body in the empire.—The London *Times*.

A PSYCHOLOGICAL CORPORATION

A "CORPORATION owned entirely by 166 psychologists!" Such a body gives at first a suggestion of unpracticality that would hardly recommend their stock to speculators on the market. For psychologists have to do not with objective substances but with the behavior of the mind—its origin, its powers and its functions. Yet this factor is really vital to every business, and the larger this human factor, the more practical the psychologist's part becomes. In this sense, these 166 psychologist stockholders are pragmatic people and not business mystics. In this distinguished directorate are such men as President Angell, Dr. G. Stanley Hall, Professor Thorndike and Dr. Cattell—the latter the president of the corporation.

The "heaven sprung message of the olden time" was, "Know thyself." It is now becoming not only the adage of the life insurance companies, of the life-prolonging institutions and of the schools, colleges and universities, but also the motto of business. Intelligence tests are the order of the day. Vague, good-natured letters of recommendation are no longer the open sesame to responsible positions. What civil service examinations have attempted to do for the public business this psychological corporation is to undertake by the application of psychological tests to those who wish to enter private business. Such independent tests made by competent disinterested experts should be of great value in determining certain kinds of fitness, which under the ordinary methods of selection are discovered usually with loss of time and wasteful experience.

William James used to say that the chief value of a college education was to enable you to know a good man when you saw one. But even if this power of discrimination were conferred with a bachelor's degree, it would not be sufficiently discerning to detect technical fitness or even professional intelligence. The psychologists aim to be brought in as appraisers and not as prophets.—The New York *Times*.

SPECIAL ARTICLES

THE MODE OF REACTION OF HIGHLY INSOLUBLE OR UNDISSOCIATED SALTS

THE interesting note by Professor Smith[1] on the precipitation of metals by hydrogen sulfide has served to call again attention to our inability to explain the precipitation and reaction of highly insoluble or undissociated salts on the basis of reaction between simple ions. A result of the famous discussion of Haber[2], Bodländer[3], Abegg *et al.*, on the interpretation and consequences of the electrometric measurements of Bodländer on the silver cyanide complexes was the conclusion reached by him that in such cases the reaction is between the precipitating ion and the complex ion rather than with one of the ions into which the complex ion dissociates. Thus he proposed writing the reaction between potassium argentocyanide solution and sodium sulfide as

$$2Ag(\overline{CN})_2 + \overline{\overline{S}} = Ag_2S + 4\overline{CN}$$

rather than

$$2\overset{+}{Ag} + \overline{\overline{S}} = Ag_2S.$$

The necessity of an explanation such as proposed by Bodländer or Smith becomes apparent from several reactions of mercuric sulfide and mercuric cyanide. In the case of mercuric sulfide one finds that there is present but one mercury and but one sulfide ion in 1,000 liters, or 10^{-5} of an ion in 10 c.c. of solution. If we assume with Haber that the minimum time that an ion remains free is 10^{-18} second, it follows that at minimum intervals of 10^{-13} second, a Hg- and a S-ion flash through the solution. Yet if we have several grams of mercuric sulfide in 10 c.c. of water, addition of a KI solution of iodine will bring the mercury into solution as rapidly as it is added. The reaction in other words goes on billions of times as fast as can be predicted even on the implied assumption of Haber that electrons are transferred between atoms with a velocity of light (3×10^{-8} cm. being taken as the order of magnitude of the atom, and 3×10^{10} cm. is the velocity of light, or 10^{-18} second is the time of transfer of an electron or minimum time of existence of an ion according to Haber). It would therefore appear that the aforementioned reaction should also be considered as a reaction between the iodine and the molecules of mercuric sulfide on the surfaces of the precipitate as well as with any mercuric sulfide or hydrosulfide molecules momentarily present in solution.

Another interesting instance is the precipitation of mercuric sulfide by the addition of sodium sulfide to a solution 0.1 M. with respect to $Hg(CN)_2$ and 1 M. with respect to KCN. From the dissociation value of 10^{-41} found by Sherrill[4] for the $Hg(CN)_4$ complexion, it can be figured on the same assumptions as made above that in 10 c.c. of such a solution one Hg-ion flashes through the solution at minimum intervals of 10 seconds. Yet *precipitation* takes place rapidly.

Since the atomic theory is much more firmly intrenched now than it was at the time when Haber first raised the question as to the character of reactions of highly insoluble or slightly dissociated substances, we must disregard his first supposition that the atomic theory may be in error, and accept as a logical explanation his second supposition that molecules and complex ions take part in such reactions.

BENJAMIN S. NEUHAUSEN
THE PHYSIOLOGICAL LABORATORY,
THE JOHNS HOPKINS UNIVERSITY

1 *J. Am. Chem. Soc.*, 44, 1500 (1922).
2 *Zeit. f. Elektrochem.*, 10, 433, 733 (1904).
3 *Ibid.*, 10, 604 (1904).
4 *Zeit. f. phys. Chem.*, 43, 717, 735 (1903).

THE MUSCH RAIN-CORRECTING MOUNTING FOR POROUS PORCELAIN ATMOMETERS[1]

Two years ago Livingston and Thone[2] described "A simplified non-absorbing mounting for porous porcelain atmometers" which, by reason of its simplicity of construction and operation as well as its inexpensiveness, has since come into very general use. The essential feature of this mounting is a short column of mercury placed near the upper end of the straight glass feed-tube which connects the atmometer above with the water reservoir below. This column of mercury, held in place by two plugs of glass wool (one above and the other below), acts very effectively as a valve to prevent the passage of water from the atmo-

1 Contribution from the Osborn Botanical Laboratory.
2 SCIENCE, N. S., 52: 85-87, 1920.

meter down the tube into the reservoir, at the same time having no effect whatever on the passage of water up the tube to replace that lost by evaporation.

Notwithstanding the obvious advantages of the Livingston-Thone mounting, there are certain objectionable features attendant upon its use which can not be overlooked. To begin with, the mercury valve with its glass wool plugs has to be properly constructed every time it is needed for use: once a season at any rate. Again, in sucking water through the tube, during the setting up of the apparatus, there is danger of drawing slivers of glass wool into the mouth. But perhaps the most serious objection has to do with the accumulation of air-bubbles in the atmometer or in connection with the glass wool plugs. It is impossible to detect bubbles in the atmometer except by taking the whole apparatus to pieces, while a bubble in the tube may sometimes become so large as to endanger the continuity of the water column.

The device to be described below was designed by Mr. Frederick Musch of New Haven as a result of experience in operating a series of porcelain atmometers for Dr. Norman Taylor—instruments equipped with the Livingston-Thone mounting. Like the latter,[3] the Musch mounting depends on a mercury valve to prevent the absorption of water, but here the resemblance ceases. The Musch device (Fig. 1, *A*) consists primarily of a J-shaped glass feed-tube, the straight end of which (*a*) extends up through the stopper of the reservoir while the curved end (*c*) passes down into the reservoir, reaching to within about half an inch of the bottom when in place. The atmometer is of course attached to the upper end of the tube, and a column of mercury (*Hg*) in the curve at the bottom of the J forms the valve. The short arm of the J is long enough to prevent the mercury splashing or being forced out of the tube into the bottle. A second important feature consists in a short side-arm (*b*), attached to the tube about an inch and a half above the bottom of the J and extending outward and upward. The outside width of the J and the outside distance between arm and tube are gauged to insure their easy insertion through the neck of the reservoir bottle. The side arm is attached at a point just high enough above the curve of the J to permit the latter to clear the bottom of the neck, while inserting, before the arm strikes the top. The side arm is long enough so that the straight part of it more than holds the mercury column, when desired, and at the same time short enough so that when in position it lies about half an inch below the shoulder of the reservoir bottle. The proper dimensions can readily be ascertained by the use of a cardboard model and a bottle of the type it is intended to use as the reservoir. The glass tubing should be of sufficiently large bore to permit the ready passage of large air bubbles.

In setting up the apparatus the feed tube is first shoved through the reservoir stopper from below and the atmometer stopper affixed to its upper end in the usual way. Next, enough mercury is placed in the crook at the bottom of the tube to completely block the passage. The whole thing is then carefully turned upside down, in such a way that the mercury column runs out of the J and into the side-arm. With mercury and tube in this position the atmometer, filled with water, is attached (or it can be attached empty and then filled either by suction or in the manner described below). The mount with attached atmometer is then turned right side up, the mercury resuming its

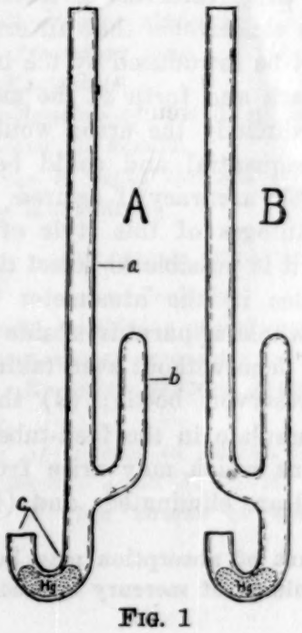

FIG. 1

[3] And like several others that had been described previously: see references in SCIENCE, 52, p. 86 (1920).

position in the crook of the J, the feed-tube is lowered into the reservoir, and the stopper is forced home. The filling of atmometer and tube is completed by turning the whole apparatus upside down and then alternately back and forth, in a manner which a little experimentation will readily suggest, due precautions being taken during this operation that the mercury retains its position in the side-arm. This same simple expedient is adopted at any time when it is desired to ascertain whether air bubbles are present in the atmometer and for getting rid of them. Any difficulty in persuading air bubbles to emerge from the atmometer into the feed-tube can be overcome by tapping the base of the instrument or by variously shaking the whole apparatus.

The Musch atmometer mounting has been thoroughly tested under various conditions, both by the writer and by others. It has already been adopted by several investigators for field work during the past season and appears to have given uniformly satisfactory results. The chief objection to which it may be open seems to be this: that during a heavy or protracted rain (or when left under a tap) there may be an initial absorption of water from without amounting to as much as 0.6 cc.[4] This absorption is due to the fact that the mercury valve does not remain stationary before the downward-pressing water column but retreats a short distance up into the short arm of the J. During a period when the weather at relatively brief intervals is alternately wet and dry it is conceivable that an error of several cc. might be introduced by the intermittent fluctuation back and forth of the mercury column; but ordinarily the error would be relatively inconsequential and could be corrected with reasonable accuracy if desired. The most obvious advantages of this style of mounting are (1) that it is possible to detect the presence of air bubbles in the atmometer by simply turning the whole apparatus upside down, and to get rid of them without even taking the cork out of the reservoir bottle; (2) that bubbles can not accumulate in the feed-tube; (3) that any objections which may arise from the use of glass wool are eliminated; and (4) that the mounting is always ready for immediate use. The contrivance can readily be made by any one adept at glass-working or it can be secured from at least one dealer in apparatus and supplies for about fifty cents.

In conclusion, brief attention is called to a modification of the Musch mounting which has been devised by Dr. F. C. Gates (see Fig. 1, *B*). This modified model recommends itself in being somewhat easier to construct and somewhat more compact and also in the fact that the mercury runs more readily back and forth between arm and valve curve than in the original model. This latter feature, however, while of advantage in some respects, may prove a disadvantage when it comes to the rapid filling of atmometer and mount, except where this is done under water (the practise followed by Dr. Gates) or by the suction method: the replacement of long air columns and large bubbles of air is interfered with by the very ease with which the mercury slides back and forth.

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[4] The amount of absorption may be greater if too short a column of mercury is used.

THE INDIANA ACADEMY OF SCIENCE

THE Indiana Academy of Science held its thirty-eighth annual meeting at Hotel Lincoln, Indianapolis, on Thursday and Friday, December 7 and 8, 1922. The officers of this meeting were as follows:

F. M. ANDREWS, Bloomington, *President.*
C. A. BEHRENS, LaFayette, *Vice-president.*
W. N. HESS, Greencastle, *Secretary.*
H. F. DIETZ, Indianapolis, *Assistant Secretary.*
W. M. BLANCHARD, Greencastle, *Treasurer.*
F. PAYNE, Bloomington, *Editor.*
F. B. WADE, Indianapolis, *Press Secretary.*

The meeting was unusually well attended and the program presented was as follows:

GENERAL SESSION

Estimating the wealth of Indiana as compared with other states. STEPHEN S. VISHER, Indiana University.

A photographic study of architectural acoustics. ARTHUR L. FOLEY.

Francis Galton, life and work. ROBERT HESSLER.

Paleolithic Stone Age in Indiana. S. FRANK BALCOM.

The archeological survey of Jefferson County. GLENN CULBERTSON.

The smog problem. ROBERT HESSLER.

Life and mind. ROBERT W. MCBRIDE.

Frank B. Wynn: In memoriam. ROBERT W. MCBRIDE.

Alexander Smith: In memoriam. R. E. LYONS.

Address of the retiring president: Some problems of plant physiology. FRANK M. ANDREWS.

Earl Jerome Grimes: In memoriam. HARRY F. DIETZ.

The scientific work of the conservation commission. By title. STANLEY COULTER.

The southern Ute Indians of the Pine River Valley, Colorado. By title. ALBERT B. REAGAN.

Indian funerals. By title. ALBERT B. REAGAN.

Twinkling star. By title. ALBERT B. REAGAN.

SECTIONAL PROGRAM

Geology and Geography

History of the lakes near Laporte, Indiana. WILLIAM MOTIER TUCKER.

Mineral resources of Indiana. W. N. LOGAN, Indiana University.

Goniobasis livescens Menke, a pleistocene shell in Furnassville Blowout, dunes of Porter County. MARCUS W. LYON, JR.

Valley-heads and sheet-wash erosion. CLYDE A. MALOTT.

The rôle of sheet-wash in erosion. CLYDE A. MALOTT.

A Pennsylvania scorpion from Clay County, Indiana, with notes on its relationship and geological significance. By title. JOHN IRVIN MOORE.

Some contrasts among the geographic subdivisions of Indiana. STEPHEN S. VISHER.

Abandoned channels in Randolph and Delaware Counties, Indiana. FREDERICK J. BREEZE.

The Muncie esker. FREDERICK J. BREEZE.

The entrenched meanders and associated terraces in the Muscatatuck River, near Vernon, Indiana. BURTON J. MALOTT. Indianapolis.

A new pleistocene gastropod from Maryland. By title. ERNEST RICE SMITH.

Archeology in Posey and Vanderburg Counties (Indiana). ANDREW J. BIGNEY.

PHYSICS AND CHEMISTRY

Chemistry

Qualitative analysis—tin group. RALPH W. HUFFERD.

Qualitative analysis—iron group. RALPH W. HUFFERD.

The normal system in quantitative analysis. E. G. MAHIN.

The effect of non-metallic impurities on cementite distribution in steel. G. B. WILSON.

Some toxic soils of Indiana. R. H. CARR.

A study of, and a modified method for, Vogel's reaction for cobalt. F. J. ALLEN and A. R. MIDDLETON.

Thiocyanotocobaltous acid and its alkali salts. F. J. ALLEN and A. R. MIDDLETON.

Evaporation of solutions in burettes. M. G. MELLON.

The use of solutions of inorganic salts as permanent color standards. M. G. MELLON, Purdue University.

An improved murexide reaction. SAMUEL E. EARP.

Fog formation in air which has passed through a silent discharge. F. O. ANDEREGG and K. B. MCEACHRON.

A type of silent discharge involving catalysis. F. O. ANDEREGG and E. H. BOWERS.

A further study of pressure reversals in the corona discharge. F. O. ANDEREGG.

The peculiar properties of water in reference to its molecular structure. F. O. ANDEREGG.

Physics

Some untenable acoustic theories. ARTHUR L. FOLEY.

Improved designs of sound "condensers." Lantern. ARTHUR L. FOLEY.

Locomotive whistle experiments. ARTHUR L. FOLEY.

Energy losses in railroad track hammers. Lantern. EDWIN MORRISON.

Scattering of light by small particles. EDWIN MORRISON.

Spectrum of phosphorescent mercury. E. K. CHAPMAN.

A method of measuring the amplification of two or more stage amplifiers. R. R. RAMSEY.

A method of securing accurate high frequency standard. R. R. RAMSEY.

An oscillographic study of an induction coil with high frequency load. F. O. ANDEREGG and K. B. MCEACHRON.

An investigation of the Foley telephone mouthpiece. JAMES E. BROCK.

Diffraction of light through circular openings. MASON E. HUFFORD.

BIOLOGICAL SCIENCES

Zoology

Some genes modifying crossing-over. F. PAYNE.

The occurrence of secondary parasitism in frog parasites. By title. GEORGE ZEBROWSKI, Purdue University.

Relation of insects to human life and to the natural sciences. JOHN J. DAVIS.

Content of first course in zoology. R. A.